

Uhde Inventa-Fischer GmbH & Co. KG

Claims

5 1. Tower reactor comprising reaction zones for simultaneous esterification and/or transesterification and also precondensation, the individual reaction zones being connected to each other and combined in the tower reactor,

10

characterised in that

the at least one tower reactor is constructed as follows:

15

- in the upper third, the tower reactor is configured in the form of a hydrocyclone (2) with attached heat exchanger (5) and has a supply line (3) for the paste, suspension and/or liquid raw material mixture,

20

- the region of the tower reactor below the hydrocyclone (2) is configured in the form of a downflow cascade (7),

25

- the cascade (7) is via a pipe in connection with the lower part of the tower reactor which is configured in the form of a single- or multiple-stage falling-film zone (9) with preliminary pressure reduction (8).

30

2. Tower reactor according to claim 1, characterised in that the hydrocyclone (2) has a vapour connection piece and is connected to a heat exchanger (5) so that the product is can be directed in the natural or enforced circulation

35

via the heat exchanger (5) into the hydrocyclone (2).

3. Tower reactor according to at least one of the claims 1 or 2, characterised in that the heat exchanger (5) has a separate gas chimney (6) which leads into an upper part of the cyclone (2).
4. Tower reactor according to at least one of the claims 1 to 3, characterised in that the cascade (7) has at least two trays, preferably four reaction trays.
5. Tower reactor according to claim 4, characterised in that a stirring assembly (10) for mixing additives is integrated in at least one cascade region.
6. Tower reactor according to claim 4, characterised in that the penultimate cascade has a discharge pipe on which an injection lance for the supply of additives is disposed.
7. Tower reactor according to at least one of the claims 1 to 6, characterised in that the pressure pipe (4) is configured as a double-walled jacket pipe which is continued in the interior of the first top cascade as a heating coil.
8. Tower reactor according to at least one of the claims 1 to 7, characterised in that the pressure pipe (4) is equipped with a volume conveyor and static mixing elements or with a mixing pump.

9. Tower reactor according to at least one of the claims 1 to 8, characterised in that the hydrocyclone has a gas inlet in the conical region.
10. Tower reactor according to at least one of the claims 1 to 9, characterised in that one of the reaction trays (7) in the vapour region has an inert gas inlet.
11. Tower reactor according to at least one of the claims 1 to 10, characterised in that the preliminary pressure reduction zone (8) for the falling-film part has the form of a hydrocyclone.
12. Tower reactor according to at least one of the claims 1 to 11, characterised in that the preliminary pressure reduction zone is equipped with at least one further pressure reduction chamber.
13. Tower reactor according to at least one of the claims 1 to 12, characterised in that the at least one falling-film zone (9) has a pipe field.
14. Tower reactor according to at least one of the claims 1 to 13, characterised in that an inlet cylinder (11) is assigned to each pipe of the pipe fields and ensures uniform wetting of the insides of the pipes, the latter
 - being equipped with overlapping, non-axial slots on the circumference,
 - a constant filling level above the series of pipes being producible because of the slot pressure loss,

- and having a maximum overflow with an indented crown,

5 - the slots being configured such that viscosity differences effect no change in the filling level, but in fact a proportional change of filling level to liquid throughput.

10 15. Tower reactor according to at least one of the claims 13 or 14, characterised in that the pipe field has channels for distribution of the melt.

15 16. Tower reactor according to at least one of the claims 13 to 15, characterised in that the pipes have a cold-rolled, drawn surface "m" according to EN ISO 1127 with a surface roughness $R_a = 0.4$ to 0.6 or R_t 4 to 6 μm .

20 17. Tower reactor according to at least one of the claims 13 to 16, characterised in that the pipe bases (9) are configured in the form of a cap.

25 18. Tower reactor according to at least one of the claims 13 to 17, characterised in that the length of the pipes of the falling-film zone is dimensioned such and the inner surfaces have such a structure that total wetting is effected as a function of the product viscosity ($L:D \geq 10 \leq 25$).

30 19. Tower reactor according to at least one of the claims 13 to 18, characterised in that the diameter of the pipes of the falling-film zone is chosen to be larger than the largest occurring reaction vapour bubble and in that the reaction vapours are directed in parallel flow with the downwardly flowing product.

20. Tower reactor according to at least one of the claims 1 to 19, characterised in that the tower reactor has dipped supply lines for the reaction gases and/or foreign gas from reaction tray to reaction tray for conducting in parallel flow through the reaction liquid, a pressure incline being produced between each tray.

5

21. Tower reactor according to at least one of the claims 1 to 20, characterised in that the entire tower reactor is equipped with a jacket for heating with organic heating medium in vapour form.

10

22. Tower reactor according to at least one of the claims 1 to 21, characterised in that all the heat exchange surfaces in the individual zones are equipped for liquid heat carriers for process-relevant temperature- and heat quantity distribution.

15

23. Tower reactor according to at least one of the claims 1 to 22, characterised in that the tower reactor has a plate base valve (3) with flow-directing formation with which the supply of the raw materials is effected centrally from below.

20

24. Tower reactor according to at least one of the claims 1 to 23, characterised in that the heat exchanger (5) has static mixing elements in order to improve mixing of the raw mixture into the reaction mixture.

25

25. Tower reactor according to at least one of the preceding claims, characterised in that the heat exchanger (5) has a three-dimensional static mixing element for producing diagonal cross-flows with simultaneous axial through-flow.

30

26. Tower reactor according to claim 25,
characterised in that the three-dimensional
static mixing element has cross-wise and diagonally
configured sheet metal sections with carrier and retaining frames in the flow direction.

5

27. Tower reactor according to claim 26, characterised in that the sheet metal sections are perforated, undulating and/or folded, i.e. pleated.

10

28. Tower reactor according to at least one of the claims 1 to 27, characterised in that the heat exchanger (5) has a heating chamber and a product chamber and also at least one separating device for horizontal separation of heating chamber and product chamber, the height of the separating device corresponding at least to the diameter of the heat exchanger pipes and the separated heat exchanger regions having a rotated offset which corresponds at most to the diameter of the heat exchanger pipes.

15

29. Tower reactor according to claim 28, characterised in that the individual separated heat exchanger regions have a different pipe division.

20

30. Tower reactor according to at least one of the claims 1 to 29, characterised in that the vapour chambers are coated in an adhesion-reducing manner.

25

31. Use of the device according to at least one of the claims 1 to 30 for continuous production of high-molecular weight polyesters by esterification of dicarboxylic acids and/or transesterification of dicarboxylic acid esters with diols in the presence of catalysts with formation of a

30

prepolymer and polycondensation thereof to form high-molecular weight polyester.